# STGW39NC60VD

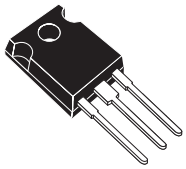
## N-channel 40A - 600V - TO-247
## Very fast switching PowerMESH™ IGBT

**PRELIMINARY DATA**

## General features

| Type | $V_{CES}$ | $V_{CE(sat)}$ (Max)@ 25°C | $I_C$ @100°C |
|---|---|---|---|
| STGW39NC60VD | 600V | <2.5V | 40A |

- Low $C_{RES}$ / $C_{IES}$ ratio (no cross conduction susceptibility)
- High frequency operation
- Very soft ultra fast recovery anti parallel diode

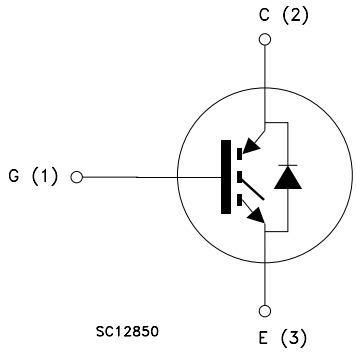


TO-247

## Description

Using the latest high voltage technology based on a patented strip layout, STMicroelectronics has designed an advanced family of IGBTs, the PowerMESH™ IGBTs, with outstanding performances. The suffix “V” identifies a familyoptimized for high frequency application.

## Internal schematic diagram




## Applications

- High frequency inverters, ups
- Motor drivers
- Induction heating

## Order codes

| Part number | Marking | Package | Packaging |
|---|---|---|---|
| STGW39NC60VD | GW39NC60VD | TO-247 | Tube |

# Contents

1 Electrical ratings . . . . . 3

2 Electrical characteristics . . . . . 4

2.1 Electrical characteristics (curves) . . . . . 6

3 Test circuit . . . . . 9

4 Package mechanical data . . . . . 10

5 Revision history . . . . . 12

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{CES}$ | Collector-emitter voltage ($V_{GS}$ = 0) | 600 | V |
| $I_C$ (1) | Collector current (continuous) at 25°C | 70 | A |
| $I_C$ (1) | Collector current (continuous) at 100°C | 40 | A |
| $I_{CL}$ (2) | Collector current (pulsed) | 220 | A |
| $V_{GE}$ | Gate-emitter voltage | ± 20 | V |
| $I_F$ | Diode RMS forward current at Tc=25°C | 15 | A |
| $P_{TOT}$ | Total dissipation at $T_C$ = 25°C | 250 | W |
| $T_j$ | Operating junction temperature | – 55 to 150 | °C |
| $T_{stg}$ | Storage temperature | | |
| $T_L$ | Maximum lead temperature for soldering purpose (1.6 mm from case, for 10 sec.) | 300 | °C |

1. Calculated according to the iterative formula:

$$I_{C(T_C)} = \frac{T_{JMAX} - T_C}{R_{THJ-C} \times V_{CESAT(MAX)(T_C, I_C)}}$$

2. Vclamp = 480V , Tj = 150°C, $R_G$ = 10Ω, $V_{GE}$= 15V

**Table 2. Thermal resistance**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $R_{thj\text{-}case}$ | Thermal resistance junction-case Max | 0.5 | °C/W |
| $R_{thj\text{-}amb}$ | Thermal resistance junction-ambient Max | 50 | °C/W |

# 2 Electrical characteristics

($T_{CASE}$=25°C unless otherwise specified)

**Table 3. Static**

| Symbol | Parameter | Test condictions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{BR(CES)}$ | Collector-emitter breakdown voltage | $I_C$ = 1mA, $V_{GE}$ = 0 | 600 | | | V |
| $V_{CE(SAT)}$ | Collector-emitter saturation voltage | $V_{GE}$=15V, $I_C$=30A,Tj=25°C<br>$V_{GE}$=15V, $I_C$=30A,Tj=125°C | | 1.8<br>1.6 | 2.5 | V<br>V |
| $V_{GE(th)}$ | Gate threshold voltage | $V_{CE}$= $V_{GE}$, $I_C$= 250µA | 3.75 | | 5.75 | V |
| $I_{CES}$ | Collector-emitter leakage current ($V_{GE}$ = 0) | $V_{CE}$ = Max rating,Tc=25°C<br>$V_{CE}$= Max rating, Tc=125°C | | | 500<br>10 | µA<br>mA |
| $I_{GES}$ | Gate-emitter leakage current ($V_{CE}$ = 0) | $V_{GE}$ = ± 20V , $V_{CE}$ = 0 | | | ± 100 | nA |
| $g_{fs}$ | Forward transconductance | $V_{CE}$ = 15V, $I_C$= 30A | | 20 | | S |

**Table 4. Dynamic**

| Symbol | Parameter | Test condictions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $C_{ies}$<br>$C_{oes}$<br>$C_{res}$ | Input capacitance<br>Output capacitance<br>Reverse transfer capacitance | $V_{CE}$ = 25V, f = 1 MHz, $V_{GE}$= 0 | | 2900<br>298<br>59 | | pF<br>pF<br>pF |
| $Q_g$<br>$Q_{ge}$<br>$Q_{gc}$ | Total gate charge<br>Gate-emitter charge<br>Gate-collector charge | $V_{CE}$ = 390V, $I_C$ = 30A,<br>$V_{GE}$ = 15V,<br>*(see Figure 16)* | | 126<br>16<br>46 | | nC<br>nC<br>nC |

**Table 5. Switching on/off (inductive load)**

| Symbol | Parameter | Test condictions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $t_{d(on)}$<br>$t_r$<br>$(di/dt)_{onf}$ | Turn-on delay time<br>Current rise time<br>Turn-on current slope | $V_{CC}$=390 V, $I_C$= 30A,<br>$R_G$=10Ω, $V_{GE}$=15V<br>Tj=25°C *(see Figure 15)* | | 33<br>13<br>2500 | | ns<br>ns<br>A/µs |
| $t_{d(on)}$<br>$t_r$<br>$(di/dt)_{on}$ | Turn-on delay time<br>Current rise time<br>Turn-on current slope | $V_{CC}$=390 V, $I_C$= 30A,<br>$R_G$=10Ω, $V_{GE}$=15V<br>Tj=125°C *(see Figure 15)* | | 32<br>14<br>2280 | | ns<br>ns<br>A/µs |
| $t_{r(Voff)}$<br>$t_{d(off)}$<br>$t_f$ | Off voltage rise time<br>Turn-off delay time<br>Current fall time | $V_{CC}$=390 V, $I_C$= 30A,<br>$R_G$=10Ω, $V_{GE}$=15V<br>Tj=25°C *(see Figure 15)* | | 33<br>178<br>65 | | ns<br>ns<br>ns |
| $t_{r(Voff)}$<br>$t_{d(off)}$<br>$t_f$ | Off voltage rise time<br>Turn-off delay time<br>Current fall time | $V_{CC}$=390 V, $I_C$= 30A,<br>$R_G$=10Ω, $V_{GE}$=15V<br>Tj=125°C *(see Figure 15)* | | 68<br>238<br>128 | | ns<br>ns<br>ns |

**Table 6. Switching energy (inductive load)**

| Symbol | Parameter | Test condictions | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| $E_{on}$ (1)<br>$E_{off}$ (2)<br>$E_{ts}$ | Turn-on switching losses<br>Turn-off switching losses<br>Total switching losses | $V_{CC}$ = 390V, $I_C$ = 30A<br>$R_G$= 10Ω, $V_{GE}$= 15V,<br>Tj= 25°C *(see Figure 17)* | | 333<br>537<br>870 | | µJ<br>µJ<br>µJ |
| $E_{on}$ (1)<br>$E_{off}$ (2)<br>$E_{ts}$ | Turn-on switching losses<br>Turn-off switching losses<br>Total switching losses | $V_{CC}$ = 390V, $I_C$ = 30A<br>$R_G$= 10Ω, $V_{GE}$= 15V,<br>Tj= 125°C *(see Figure 17)* | | 618<br>1125<br>1743 | | µJ<br>µJ<br>µJ |

1. Eon is the tun-on losses when a typical diode is used in the test circuit in figure 2 Eon include diode recovery energy. If the IGBT is offered in a package with a co-pak diode, the co-pack diode is used as external diode. IGBTs & Diode are at the same temperature (25°C and 125°C)
2. Turn-off losses include also the tail of the collector current

**Table 7. Collector-emitter diode**

| Symbol | Parameter | Test condictions | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| $V_f$ | Forward on-voltage | If = 15A<br>If = 15A, Tj = 125°C | | 1.6<br>1.4 | 2.8 | V<br>V |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{rrm}$ | Reverse recovery time<br>Reverse recovery charge<br>Reverse recovery current | If = 15A, $V_R$ = 40 V,<br>$T_j$ = 25°C, di/dt =100A/µs<br>*(see Figure 18)* | | 45<br>56<br>2.55 | | ns<br>nC<br>A |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{rrm}$ | Reverse recovery time<br>Reverse recovery charge<br>Reverse recovery current | If = 15A, $V_R$ = 40V,<br>$T_j$ = 125°C,di/dt =100A/µs<br>*(see Figure 18)* | | 100<br>290<br>5.8 | | ns<br>nC<br>A |

## 2.1 Electrical characteristics (curves)

**Figure 1. Output characterisics**

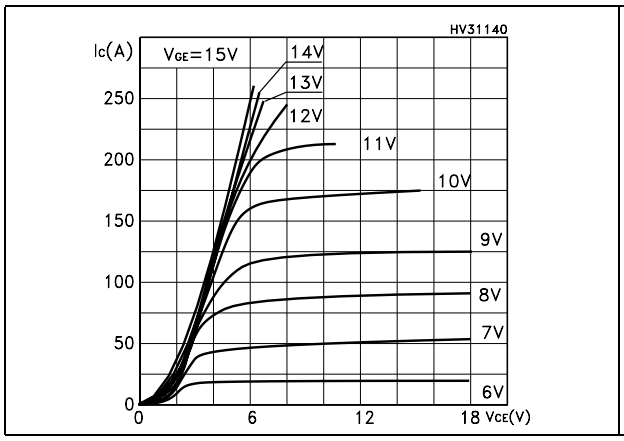



**Figure 2. Transfer characteristics**

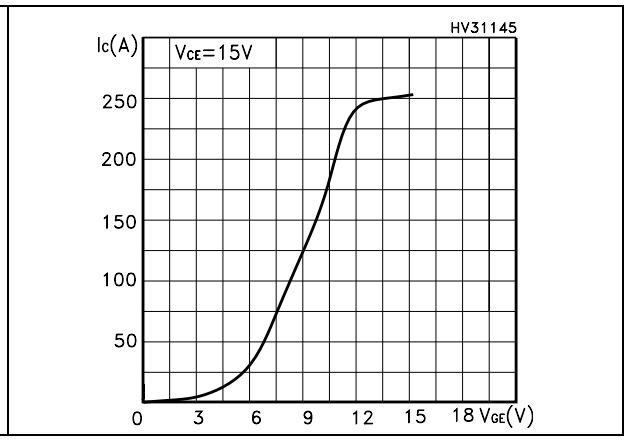



**Figure 3. Transconductance**

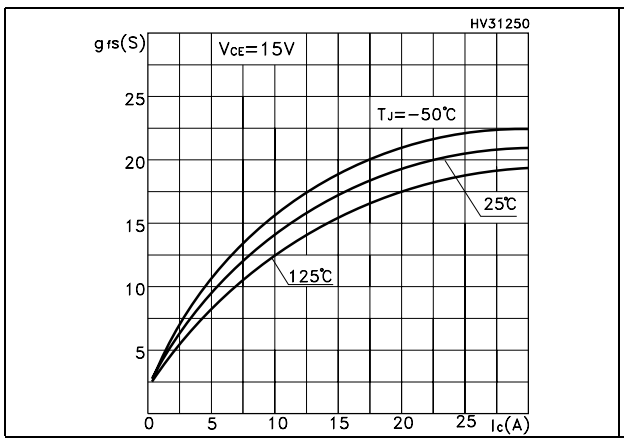



**Figure 4. Collector-emitter on voltage vs temperature**

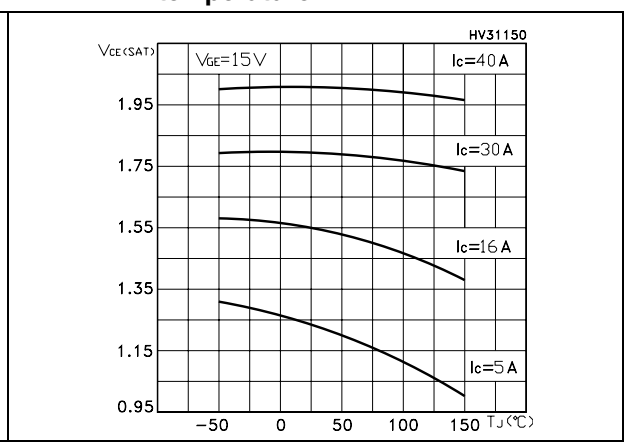



**Figure 5. Collector-emitter on voltage vs collector current**

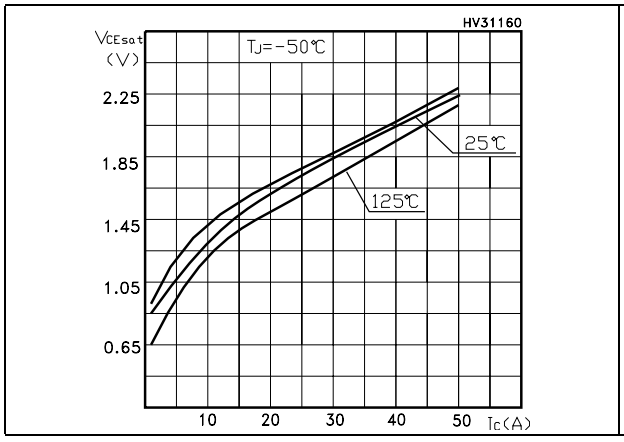



**Figure 6. Normalized gate threshold vs temperature**

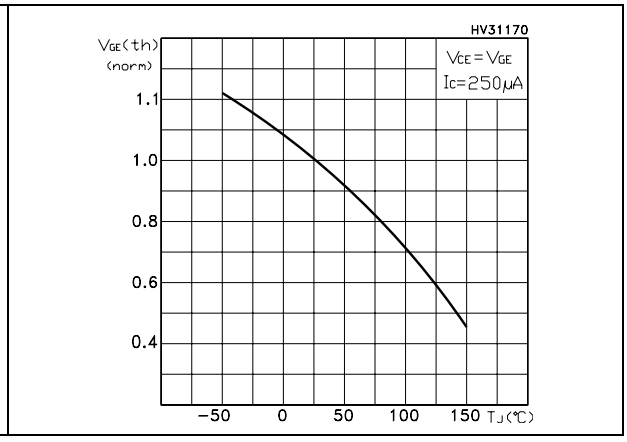


**Figure 7. Normalized breakdown voltage vs temperature**

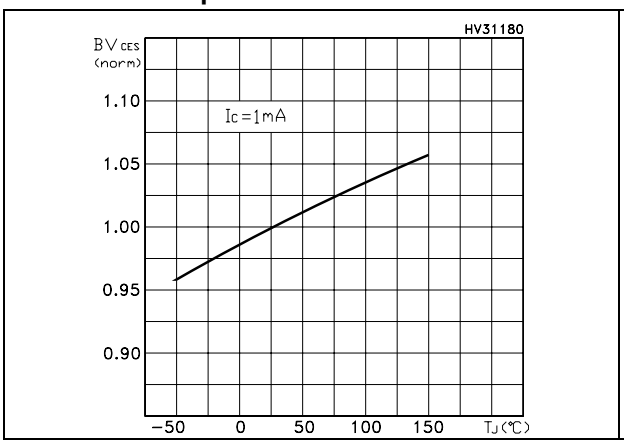



**Figure 8. Gate charge vs gate-emitter voltage**

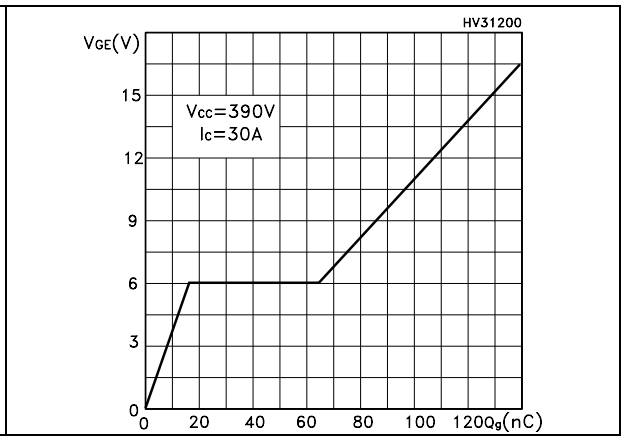



**Figure 9. Capacitance variations**

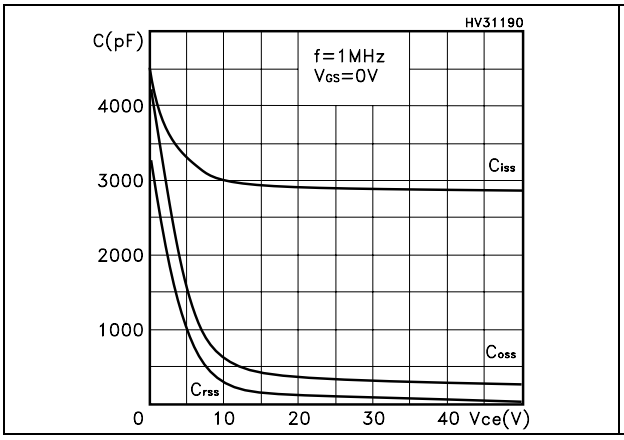



**Figure 10. Switching losses vs temperature**

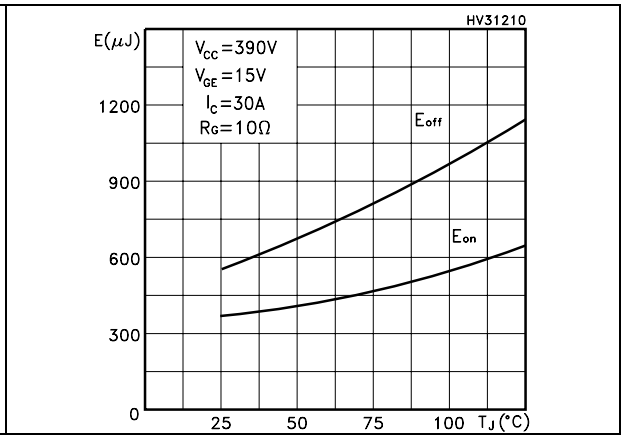



**Figure 11. Switching losses vs gate resistance**

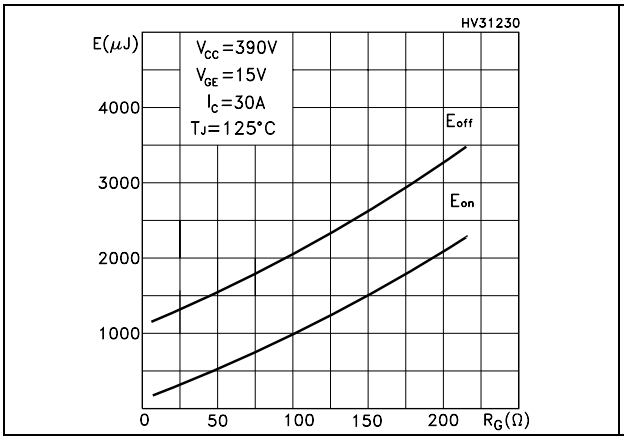



**Figure 12. Switching losses vs collector current**

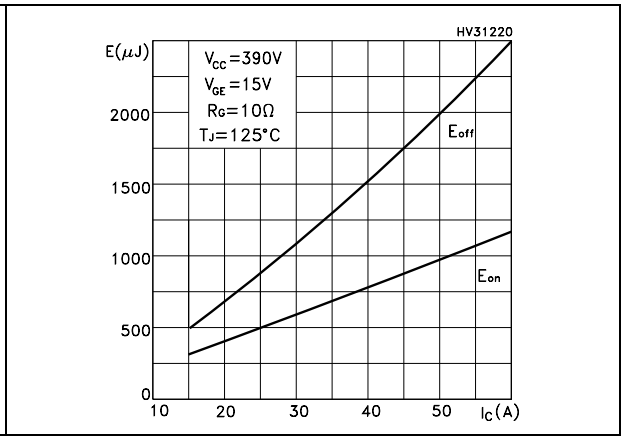


**Figure 13. Thermal impedance**

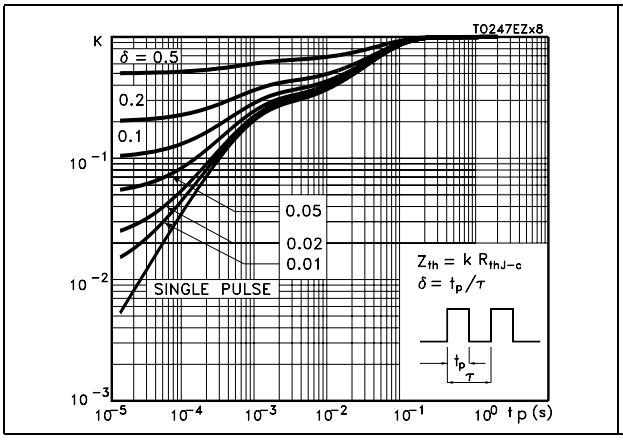
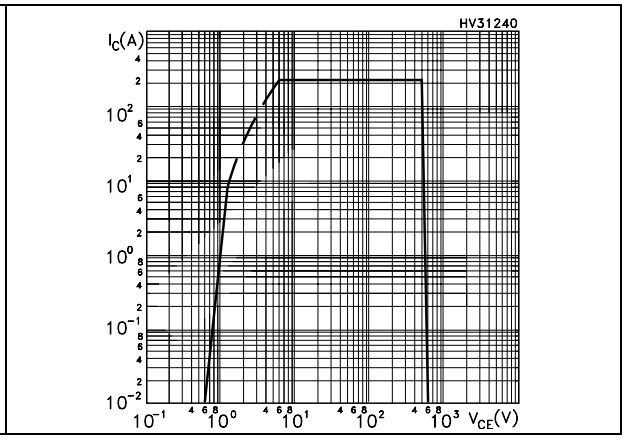



**Figure 14. Turn-off SOA**



# 3 Test circuit

**Figure 15. Test circuit for inductive load switching**

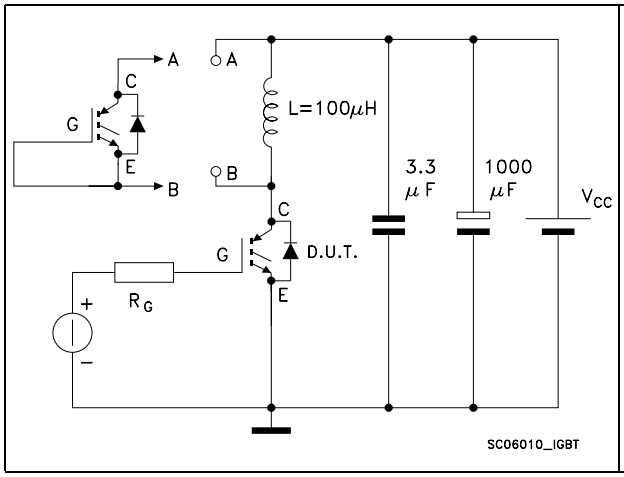



**Figure 16. Gate charge test circuit**

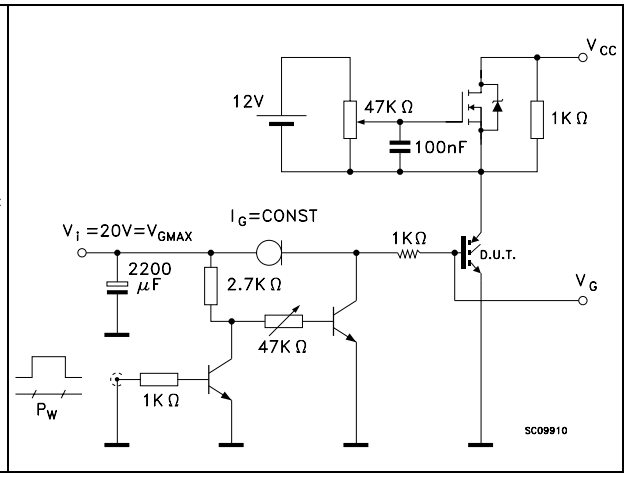



**Figure 17. Switching waveforms**

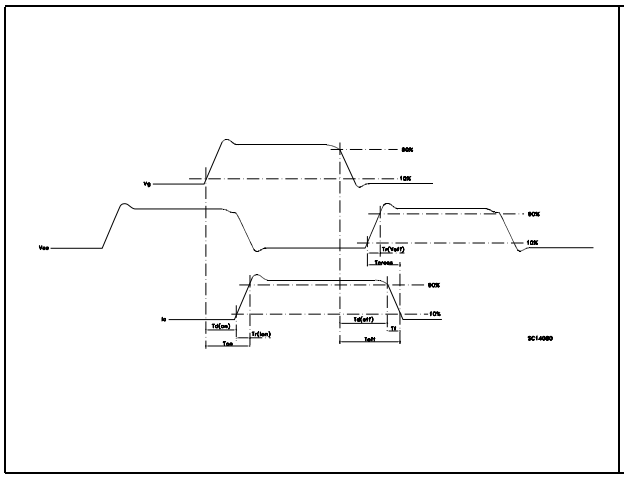
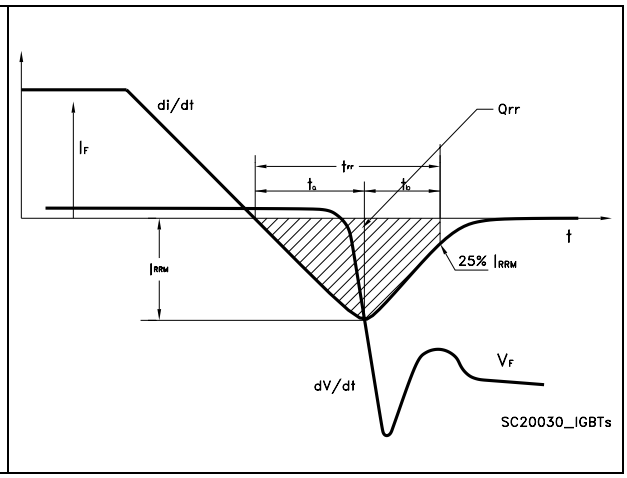


**Figure 18. Diode recovery times waveform**

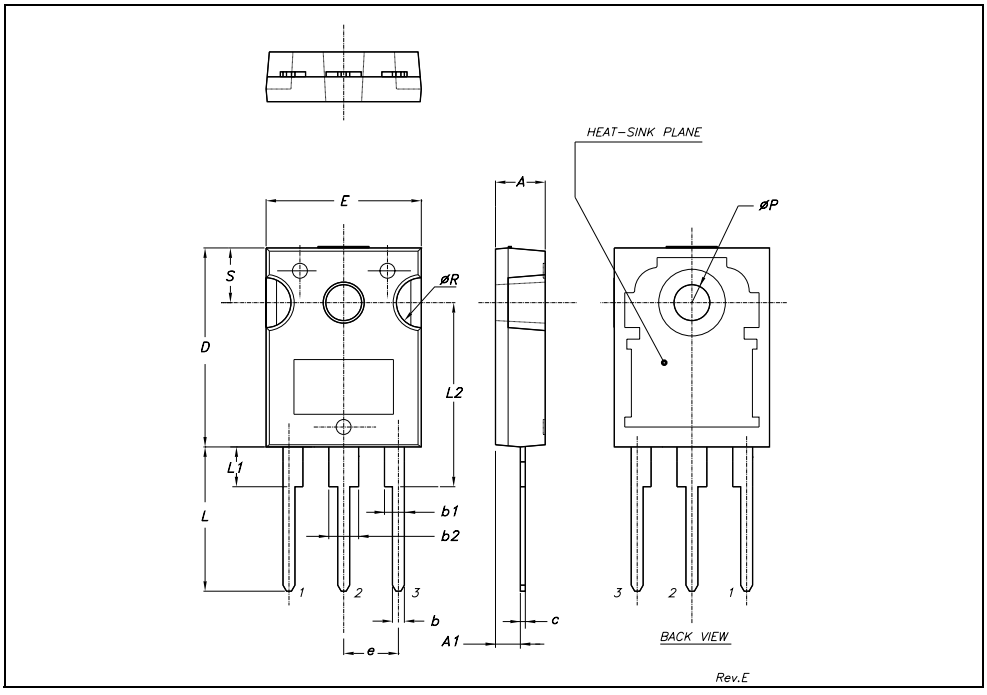


# 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect . The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: *www.st.com*

## TO-247 MECHANICAL DATA

| DIM. | mm. | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | 4.85 | | 5.15 | 0.19 | | 0.20 |
| A1 | 2.20 | | 2.60 | 0.086 | | 0.102 |
| b | 1.0 | | 1.40 | 0.039 | | 0.055 |
| b1 | 2.0 | | 2.40 | 0.079 | | 0.094 |
| b2 | 3.0 | | 3.40 | 0.118 | | 0.134 |
| c | 0.40 | | 0.80 | 0.015 | | 0.03 |
| D | 19.85 | | 20.15 | 0.781 | | 0.793 |
| E | 15.45 | | 15.75 | 0.608 | | 0.620 |
| e | | 5.45 | | | 0.214 | |
| L | 14.20 | | 14.80 | 0.560 | | 0.582 |
| L1 | 3.70 | | 4.30 | 0.14 | | 0.17 |
| L2 | | 18.50 | | | 0.728 | |
| øP | 3.55 | | 3.65 | 0.140 | | 0.143 |
| øR | 4.50 | | 5.50 | 0.177 | | 0.216 |
| S | | 5.50 | | | 0.216 | |



# 5 Revision history

Table 8. Document revision history

| Date | Revision | Changes |
|---|---|---|
| 17-Nov-2005 | 1 | First release |
| 05-May-2006 | 2 | Inserted curves |
| 10-Jul-2006 | 3 | Modified value on *Absolute maximum ratings* |
| 28-Jul-2006 | 4 | Modified value on *Dynamic* |

**Please Read Carefully:**

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries (“ST”) reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST’s terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

**UNLESS OTHERWISE SET FORTH IN ST’S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.**

**UNLESS EXPRESSLY APPROVED IN WRITING BY AN AUTHORIZED ST REPRESENTATIVE, ST PRODUCTS ARE NOT RECOMMENDED, AUTHORIZED OR WARRANTED FOR USE IN MILITARY, AIR CRAFT, SPACE, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE. ST PRODUCTS WHICH ARE NOT SPECIFIED AS "AUTOMOTIVE GRADE" MAY ONLY BE USED IN AUTOMOTIVE APPLICATIONS AT USER’S OWN RISK.**

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.



STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

**www.st.com**